Estimation of Recreational Damages Caused by Poultry Litter in the Illinois River Watershed and throughout Eastern Oklahoma

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Confidential Attorney/Consultant Work Product; Prepared in Support of Pending Litigation

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Recreation in Oklahoma

- 80% of Oklahoma (OK) residents participate in outdoor recreation (Fisher, 2002)
- Recreational activities in OK by U.S. residents (U.S. Department of Interior et al., 2001)
  - Fishing
    - 12.7 million fishing days in 2001
    - 88% of all days occur on ponds, lakes, or reservoirs; 12% on rivers and streams
    - Average trip expenditures of ~$18 per day
      - Includes food, lodging, transportation

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Recreation in Oklahoma (cont.)

- Hunting
  - 5.7 million hunting days
  - Average trip expenditure of ~$18 per day
- Wildlife watching
  - 1.1 million participants
  - Average expenditure of $182 per participant per year

Eastern Oklahoma Recreation

- 12% of all OK fishing license holders fished in and took trips to Eastern OK rivers and streams in 1999
- 70% fished for black bass species
- Follow up survey of Eastern OK residents in study indicated:
  - Average of 13 to 27 trips per year to Eastern OK streams/rivers depending on license type (i.e., fishing and hunting combination vs. fishing only)
- Annual benefits to region (1993) = $24 million
  - Based on expenditures in region by anglers

Source: Fisher, 2002.

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Recreational Resources in the Illinois River Basin

- The Illinois River (ILR) and Tenkiller Lake (TKL) attract visitors from across the Midwest, including Arkansas, Kansas, Michigan, Oklahoma, and Texas
- ILR corridor
  - Encompasses ILR and tributaries (Baron and Flint creeks)
    - One of several state-designated scenic rivers
  - 56 of the 99 miles of the ILR (above TKL) is located within the OK State boundary

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Recreational Resources in the Illinois River Basin (cont.)

- Tenkiller Ferry Lake (TKL)
  - Army Corps of Engineers project built in the early 1950s for flood control, water supply, and power generation (Soil Conservation Service, 1992)
  - Now a huge recreational draw
    - 10 marinas, 20 launching ramps, and 14 campgrounds
  - The 12,900 acre reservoir is located 13 miles above ILR confluence with Arkansas River
- Tenkiller State Park and Cherokee Landing State Park
  - Located on TKL with a total combined area of 1,334 acres

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Uniqueness of the ILR and TKL

- Other resources in OK have some of the qualities of ILR and TKL
- Comparables ILR:
  - Spring River (clear, no congestion)
  - Glover River is similar
  - Skiatook (north of Tulsa)
- TKL:
  - Broken Bow (150 miles away)
    - Deep, fairly clear, warmer than TKL
  - Ft. Gibson Reservoir within 50 miles
    - Naturally green colored water, contaminated
  - Kerr Reservoir within 50 miles (has scuba)

Sources: personal communication, Lowell Caneday, Oklahoma State University, November 8, 2004; personal communication, Conrad Kleinholtz, Langston University, November 8, 2004.

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Uniqueness of the ILR and TKL (cont.)

- Portions of Arkansas contains river corridors comparable to the ILR (personal communication, Conrad Kleinholtz, Langston University, November 8, 2004)
- ILR and TKL have no real substitutes that are nearby
  - Therefore, values are higher

Recreational Activities in ILR Corridor and at TKL

- ILR corridor (Jett, 2000)
  - Floating (canoe, raft, kayak, tube) – most documented activity
  - Camping, swimming, hiking, hunting, fishing, among others
- TKL and state parks (Caneday and Neal, 1996)
  - 75% of use occurs between April and September (Warner, 1973)
  - Most frequent recreation activities are swimming, fishing, boating, waterskiing, picnicking, hiking
  - Bass tournaments (ODWC, 2003)
    - Compared against other top 20 tournament lakes, TKL in 50% range in five indicators (avg. # bass caught, # success, avg. weight/bass, avg. 1st place weight, angler hours per >5 pound bass)
  - Other activities: camping, sightseeing, sunbathing, wildlife viewing, cycling (personal communication, Ed Fite, OSRC, October 29, 2004)
  - Scuba

Scuba

- One of the most unique activities at TKL
- Divers from OK, KS, TX, AR (Greater Tenkiller Area Association, 2004)
- Terrain: Underwater rock cliffs throughout the lake; up to 165 feet deep
- Divers can spearfish
- Underwater "Old West" town flooded when lake created
- Historically known for incredible water clarity
  - Visitors guide cites visibility range of 8-35 feet
  - Dive shops may vary in their assessment of water quality
  - Reduced water clarity at TKL may impact visitation by those who scuba dive at the lake for certification and recreation purposes

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Fishing

- Conflicting information whether water quality has led to a reduction in fish stocks
  - Some argue that reduced success rates for anglers in TKL partially attributed to a reduction in water quality (especially DO levels) (Oklahoma Department of Wildlife Conservation, as cited in Caneday and Neal, 1996)
- Change in species diversity = shift from smallmouth bass prevalence to large mouth bass and shad (personal communication, Conrad Kleinholtz, Langston University, November 8, 2004)

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Fishing (cont.)

- Bass tournaments
  - Overall increases in popularity of bass tournaments through recent years may have caused reductions due to over fishing
  - Catch and release
    - Smallmouth bass are sensitive and territorial
    - In the ODWC 1995 Bass Report, OWDC cited 40% mortality from catch and release tournaments (ODWC, as cited in Caneday and Neal, 1996)

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Recreational Users of the Illinois Basin's Natural Resources

- Traditionally, Tulsa area residents were primary users
  - Historical knowledge of area
- Current users are multi-day vacationers not from region (different perceptions, attitudes, preferences)
- TKL experience has changed
  - Demand for increases in the number of commercial facilities
  - Less concerned with water quality
- Current users may be less interested in water quality than historical users
  - Survey rating of current users of resource quality is generally high
  - Major concerns are litter, crowding, and unrefined behavior

Source: personal communication, Lowell Caneday, Oklahoma State University, November 8, 2004.

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Recreational Users of the Illinois Basin's Natural Resources (cont.)

- Floater average satisfaction rating of 3.74 (on a 1-to-5 scale) (Jett, 2000)
  - Overall satisfaction = 3.72
  - Satisfaction of natural environment = 3.97
  - Satisfaction of management/outfitter = 3.53
  - 66% of floaters are return visitors

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Environmental Problems Along the ILR and at TKL Potentially Affecting Recreation

1) Nutrient loadings causing eutrophication
   - Algae blooms
   - Decreased water clarity
   - Water odor
2) Reduction in river aesthetics
3) Crowding and use exceeding environmental carrying capacity

Environmental Problems Along the ILR and at TKL Potentially Affecting Recreation (cont.)

- Agricultural-source pollution
  - Runoff of agricultural waste from fields
    - Applied poultry litter
      - Poultry is responsible for 34% of the 4,284,800 lbs of phosphorous produced in basin (Haraughty, 1999)
    - Cow manure
    - Other fertilizers/pesticides
  - Increased sedimentation/bank erosion
    - Unrestricted grazing
    - Lack of riparian buffer zones
  - Runoff from nurseries

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Environmental Problems Along the ILR and at TKL Potentially Affecting Recreation (cont.)

- Human use sources
  - Recreation
    - Illegal dumping (trash, litter, chemicals)
    - Crowding: Difficult to fish ILR because of the number of floaters
  - TKL and river corridor development
    - Loss of riparian zones (~90% private) (personal communication, Lowell Caneday, Oklahoma State University, November 8, 2004; personal communication, Ed Fite, OSRC, October 29, 2004)
      - Increased bank erosion and loss of aesthetics
    - Runoff from streets and highways
    - Municipal waste water treatment system discharges
    - Leaky private on site waste water treatment systems (septic systems)

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The Problem of Eutrophication in the ILR Basin

- The Oklahoma Scenic Rivers Commission cites primary threats to TKL and ILR include:
  - Runoff from nearby poultry farms
  - Runoff from commercial nurseries
  - Stream bank erosion from unconfined livestock
  - Urban development (septic systems) (as cited in J. Jett, 2000)
- OWRB argues that
  - Beneficial uses of the ILR (recreational and ecological) may be impaired
  - Its status as a State Scenic River may be threatened (OWRB, 2004)
- Of note: Eutrophication increases the probability of a warm water amoeba being present
  - 100% fatal
  - 3-4 people die yearly in central OK (personal communication, Conrad Kleinholtz, Langston University, November 8, 2004)

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Economic/Policy Studies of Eutrophication

- Eutrophication is a significant problem and has been well studied
  - A multitude of studies have been undertaken by government agencies, universities, research organizations
- EPA has conducted over 500 studies on eutrophic bodies of water
  - Great Lakes modeling staff (EPA)
    - "Saginaw Bay Eutrophication Project"
    - "Southern Lake Huron Eutrophication Project"
    - "Lake Erie Eutrophication Project"
    - U.S. EPA. 2002. "Waquoit Bay Watershed Ecological Risk Assessment: The Effect of Land-Derived Nitrogen Loads on Estuarine Eutrophication." National Center for Environmental Assessment, Washington, DC; EPA/600/R-02/079.

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Examples of Other Eutrophication Studies

- EPA Office of Water. 1998. Tampa Bay Atmospheric Deposition Study.
- Carpenter, S. et al. 1999. Management of eutrophication for lakes subject to potentially irreversible change. *Ecological Applications.*
- Pitois, S. et al. 2001. Sources of the eutrophication problems associated with toxic algae: An overview. *Journal of Environmental Health.*
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- Bowen, J.L. and I. Valiela. 2001. The ecological effects of urbanization of coastal watersheds: Historical increases in nitrogen loads and eutrophication of Waquoit Bay estuaries. *Can. J. Fish. Aquat. Sci.* 58:1489-1500.

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Examples of Other Eutrophication Studies (cont.)

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Potential Future Events if Eutrophication Remains Uncontrolled

- Potential results of current practices in the basin are (Caneday and Hutchinson, 1995):
  - Continuing water quality deterioration
  - Increasing algae growth, turbidity, and odors
  - Increasing water treatment expenses
  - Groundwater contamination (making wells nonpotable)
  - The need for fish consumption advisories at times
  - Swimming advisories at times
  - Loss of native plants and animals

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Methods to Estimate Recreational Damages

- Revealed Preference Methods
  - Based on observed behavior
  - Recreation demand model
- Stated Preference Methods
  - Based on survey responses
  - Contingent valuation
  - Conjoint analysis
- Benefit Transfer
  - Based on existing data and literature
  - Rapid and cost-effective
  - Method used for this preliminary estimation of damages

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Categories of Damages

- Potential categories of recreation damages
  - User substitution away from resource to other sites and activities
  - Lost enjoyment from impaired resource
- Substitution
  - Studies indicate that environmental carrying capacity on the lake is at its limit and exceeded at times of the year (Caneday and Neal, 1996)
  - Substitution may be as likely to occur from overcrowding than eutrophication
    - Limit the number of commercial flotation (canoes, boats, inner tubes, etc.) through issuing 3,900 permits annually (ILR and nearby Flint and Barren creeks) (Jett, 2000)
    - Charge a $1 fee to float river

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Lost Enjoyment from Impaired Resource

- Reduced quality of river and lake reduces user enjoyment of the trips that continue to occur (Caneday, 2002)
- Trash, overcrowding, water quality, changes in fish types, etc.

Activity Level: Illinois River

Source	Year	# float trips annually (typically 3 people per boat)	# visitors using corridor for water based activities (floaters other activities)	# visitors per year in ILR basin Corridor
Wikle, T.A.	1970	300	----	----
Wikle, T.A.	1975	36,000	----	---
Wikle, T.A.	1990	60,000	----	----
Haraughty, S.	1999	----	180,000	400,000
Water Quality Initiative	1994	53,000	159,000	----
US Department of Interior	2001	----	-----	350,000
Jett, J.	2000	58,000	180,000	400,000
OSRC (personal communication, Ed Fite, October 29, 2004)	2004	-----	200,000	500,000

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Activity Level: Tenkiller Lake

Source	Year	TKL visitor days	Number of TKL visitors per year
GORP	2003	----	721,278 (ACE sites)
U.S. Department of Interior	2001	----	1,500,000
Haraughty, S.	1999		1,500,000
Caneday and Neal	1996	---	192,754 (state park sites)
Caneday and Neal	1995	---	414, 846 (ACE sites)
Jobe, N.	1994	2.2 million	1,505,600
Jobe, N.	1992		1,650,400
Jobe, N.	1990		1,607,000
Jobe, N.	1988		2,315,800

ACE: Army Corp of Engineers; GORP: Encyclopedic resource for outdoor recreation (online). The sites reported values are based on those reported by the ACE.

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Total Number of Visitors in Assessment Area

- ILR = 400,000 visitors per year
- TKL = average number of visitors/year from 1989 to 1994 (Jobe,1996) = 1,568,233
- Total visitors = 2.0 million visitors per year

Total User Days in ILR Basin

- ILR recreationist (Jett, 2000)
  - 2000 survey: Average number of nights per recreationist = 0.9884 nights
    - Assume that a single night stay = 1.5 user days
    - Therefore, average number of days per recreationist = ~1.5
    - (# of users) x (# days per user) = total user days
    - (400,000 users) x (1.5 days) = 600,000 users days

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Total User Days at TKL

- Jobe (1996) study indicated:
  - 1994: 1,505,600 visitors to TKL
  - = 1.5 days per visitor
  - = 2.2 million visitor days

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Total User Days at TKL and ILR

- ILR = 600,000 user days

+

- TKL = 2.4 million user days

- **Total = 3.0 million user days per year**

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% Participation by Type of Recreation

Caneday and Neal, 2000 (based on 1987 survey of 1,597 visitors at the state parks on TKL)

Activity	% of survey group
Swimming	44.5%
Fishing	37.6%
Boating	21%
Waterskiing	12.5%
Picnicking	35%
walking	32.9%
Hiking	21%

Without the raw data, it is difficult to tell what the % of water-based participation is because the user engaged in more than one activity.

All of the above activities are arguably water based.

More recent U.S. Army Corp site survey data indicate 74% of all visitors to TKL are involved in water-based activities (Jobe, 1996).

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% Participation by Type of Recreation (cont.)

Warner et al., 1973 (participating rate of activities at TKL from a sample of 393 visitors using TKL in 1972)

Note that this study suggests that at least 83.7% of visitors surveyed engaged in water-based activities

Activity	% participation by survey group
Swim	83.7%
Relax	61.6%
Fish	57.5%
Pleasure boat	56.2%
Water ski	51.9%
Sunbath	41.0%
Cycle	15.3%
Hike	11.7%
Nature study	9.7%
Scuba	7.4%
Other	2.5%

% of Visitors Directly Impacted by Water Quality

- Users impacted by water quality and the aesthetics of the environment near the water body
- 74% (perhaps higher) TKL users engage in water-based activities (Jobe, 1996)
- 3.0 million user days x 74% = 2.2 million water-based user days per year impacted (in 1994, 2004$)

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Expenditures for ILR Recreationists

Expenditures for an ILR recreationist (J. Jett, 2000)

Expenditure (floating and/or outfitter)	Expenditure (gasoline)	Expenditure (food/drink)	Expenditure (lodging)	Expenditure (other recreation)	Total Expenditure $ per trip
$47.12	$18.99	$43.97	$16.53	$10.62	$137.23

Number of days per recreationist is 1.98

Therefore, total expenditures per day is $69.31

An ILR river floater's daily expenditure is $55 (personal communication, Ed Fite, OSRC, October 29, 2004)

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Estimating Value of Lost Enjoyment through Expenditures

- The value of lost enjoyment from a reduction in water quality = 5%-10% of trip expenditures
  - Based on previous studies in Wisconsin and Montana (Hagler Bailly Consulting, Inc., 1995, 1996)
- Expenditures = $69.31 per user day
  - Lost enjoyment (using 5%-10%) = $3-$6 per user day

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Estimating Value of Lost Enjoyment through Total Willingness to Pay per Day

- The value of lost enjoyment from a reduction in water quality = 20% of total willingness to pay (WTP), based on Great Lakes studies
- Average consumer surplus per day = $32.80 (Warner, 1973)
  - Lost enjoyment (using 20%) = $6 per day
- Accounts for closure of ILR one weekend per year (personal communication, Ed Fite, OSRC, October 29, 2004)

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Willingness to Pay for Recreational Experience at TKL

- Warner (1973) estimated consumer surplus by distance traveled for TKL recreationists using a linear regression model
  - Average consumer surplus $32.80 per visitor day for all types of recreation
- Summary statistics on average consumer surplus values per activity day per person from recreation demand studies — 1967 to 1998 (Rosenberger and Loomis, 2000)

Activity	Mean consumer surplus (2004$)
Camping	$36.54
Picnicking	$42.43
Swimming	$25.36
Fishing	$43.19
sightseeing	$43.17
Motorized boating	$74.09
Nonmotorized boating	$41.82
Mean	**$43.80**

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Other Recreational Values for Reductions in Toxins and Other Contaminants

Source	Resource change	Value estimate (2004$)
Herriges et al., 1999	Great lakes: 20% reduction in contaminant levels in fish	$12 -$15 per Great Lakes fishing day $81-107 per angler per season
Breffle et al., 1999	Reduction in FCA levels* Level 9 to Level 1 Level 2 to Level 1	 $26 per fishing day $2 per fishing day
Parsons et al., 1999	Remove FCAs from 2 of 14 middle Tennessee reservoirs	$16-$17 per trip to contaminated site
Chen and Cosslett, 1998	Remove Area of Concern designation at all Michigan Great Lakes sites (total of 14)	$4-$19 per Great Lakes fishing trip
Lyke, 1993	Eliminate all contaminants that threaten human health in Wisconsin Great Lakes	$4 -$16 per Great Lakes fishing day $54-$191 per angler per season

* Level 9 = "do not eat" for trout/salmon, walleye, and smallmouth bass; Level 2 = "one meal per week" for trout/salmon and walleye and "unlimited consumption" of smallmouth bass; Level 1 = "unlimited consumption" for all species.

Value of Lost Enjoyment - Summary

- Both methods imply value per user day of a few dollars
- However, this is based on cases with more severe (more often "officially-listed") contamination problems
- Floating the ILR costs $1; when it was $4, outfitters believe use was reduced (personal communication, Lowell Caneday, Oklahoma State University, November 8, 2004)
  - Suggests a WTP of a few dollars
- Lost enjoyment at TKL and ILR = ~$1 per user day
  - Adjusting for ILR closure would make user day value increase slightly

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Annual Damages from Lost Enjoyment

- 2.2 million water-based user days per year x $1 = $2.2 million per year (in 1994, 2004$)
- Use over time:
  - For TKL:
    - 1989 -1994: Actual user days known
    - 1980 -1988: Use 1989 (the minimum value)
    - 1995 - forward : Use average of known years
  - For ILR:
    - Assume use stays constant at 600,000 user days

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Aggregation of Damages from Lost Enjoyment

- Begin calculation of damages in 1981
  - 1980 damages are 0% of WTP
  - Damages per user day increase linearly until 100% in 1989, when reach 100% of WTP
    - Increase (~11% year)
- Discount rate of 3%
- 5, 10, 20 year estimates
- Moratorium (December 31, 2004), but no remediation
- Natural recovery

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Summary of Damages

Time period	Damages (2004$)
Past damages (1981-2003)	$51,000,000
Present year damages (2004)	$2,000,000
Future damages: 5-year (2005-2009)	$4,000,000
Future damages: 10-year (2005-2014)	$8,000,000
Future damages: 20-year (2005-2024)	$16,000,000
Total damages	$57,000,000 – $69,000,000

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Uncertainties

- Assumptions underlying calculations may change with additional information
  - WTP (user day values probably between $1 and $5, but may be as high as $10)
    - For Eucha/Spavinaw, lost WTP due to 46 tons phosphorous/year = $5 per user day (Storm et al., 2003)
  - User frequency and concentration (may change in the future)
- Carrying capacity may be reached, but current activity may have displaced higher value activity (e.g., smallmouth bass prevalence reduced by pollution and smallmouth bass anglers have moved elsewhere)

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Recreational Damages for All Watersheds

- Best estimate of total user days at prominent surface water throughout Eastern OK is 12 million[1]
  - Total use in Eastern OK / (IRB +TKL use) = multiplier >1
  - 12 million / 3.0 million = 4
- Total damages = 4 x (damages to TKL/ILR)

[1] Based on user days reported by Army Corp of Engineers (ACE) at ACE lakes in the region.

Recreational Damages for All Watersheds (cont.)

- Potential biases in both directions
  - ILR/TKL probably higher values, so applying to other watersheds may overstate damages
  - Eastern OK as a whole has fewer substitutes than any individual watershed
    - Aggregation of sites makes them collectively more highly valued = underestimation of damages

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